Comparative economics of Banana cultivation in Anand district of Gujarat

A.K. Dave[1], Y.C. Zala[2] and R.S. Pundir[3]*

[1]Department of Agricultural Economics, B.A. College of Agriculture, Anand Agricultural University, Anand, 388110, Gujarat, India
[2]International Agribusiness Management Institute, Anand Agricultural University, Anand-388110, India
[3]International Agribusiness Management Institute, Agricultural University, Anand-388110, Gujarat, India

ABSTRACT

The comparative economics of banana cultivation under drip and conventional irrigation methods was studied by collecting data from 60 drip farms and 60 non-drip farms of Anand district during 2009-10. Though the investment on drip irrigation system for banana crop was expensive (₹ 84115/ha), the total cost of cultivation in drip farms (₹ 150098/ha) was slightly less than that in non-drip farms (₹ 151735/ha). The yield (13.94 per cent) and net profit (52.76 per cent) of banana in drip farms were higher as compared to non-drip farms. Input-Output ratio over cost-c_2 under drip and flood method of irrigation was 2.10 and 1.71, respectively. The Cobb-Douglas production function was employed to establish the input-output relationship. The sum of regression co-efficient ($\Sigma bi's$) was 1.072 and 1.109 for non-drip and drip banana farms, respectively indicating increasing return to scale. MVP/FC ratios were also worked out to examine the resource use efficiency more reliably. It was found that the resources viz, plantlets (tissue culture), irrigation and area were underutilized in drip farms indicating these inputs were not optimum in context to other inputs in order to get maximum profit and therefore, there is yet some scope to increase productivity in the study area of drip farms of banana.

Keywords: Comparative economics, drip and conventional methods of irrigation, production function, banana

JEL Classification: Q25, Q15, Q16

Access this article online	
Publisher	Website: http://www.ndpublisher.in
	DOI: 10.5958/0976-4666.2016.00039.5

India is fortunate to have a wide range of fruit crops grown in different agro climatic zones and has a pride of place in the production of fruit crops. Banana is a very popular fruit due to its low price and high nutritive value. It is an important fruit crop grown in India next to mango. The area under banana was 7.09 lakh hectares in 2008-09 and the production was 26.22 million tonnes in 2008-09 (Anonymous, 2009). The important banana

Address for correspondence

R.S. Pundir: International Agribusiness Management Institute, Agricultural University, Anand-388110, Gujarat, India

E-mail: rspundir@aau.in

growing states are Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Bihar and Madhya Pradesh which together accounted for about 87.01 per cent of total banana production in the country. Among different states in the country, Gujarat has accounted for 13.44 per cent of total banana production and it ranks third in production (Anonymous, 2008). Though banana is highly water consuming horticultural crop grown in Gujarat state, it is generally observed that the crop has been irrigated through flood irrigation method i.e. conventional method of irrigation since long. Available estimates indicate that water use efficiency under flood method of irrigation is only about 35 to 40 per cent because of huge conveyance and distribution losses (INCID, 1994). One of the management strategies introduced to control water consumption in Indian agriculture is micro irrigation (MI) which includes mainly drip and sprinkler irrigation method. Under micro-irrigation, unlike flood method of irrigation (FMI), water is supplied at a required interval and quantity using pipe network, emitters and nozzles. Therefore, the conveyance and distribution losses are reduced completely resulting in higher water use efficiency under MI. Therefore, the Government is also encouraging micro irrigation system which save water and maintain sustainability of the soil. In June 2009, more than 93,000 farmers of Gujarat adopted drip irrigation for their total 1.51 lakh hectare land (GoG, 2010).

In view of the above, the present study was conducted to compare the cost, returns and resource use efficiency in banana cultivation under drip and conventional methods of irrigation.

Database and Methodology

The study was conducted in Anand district which occupied 22.21 per cent area under banana cultivation in Gujarat. At the first stage, out of eight talukas of Anand district, Anand taluka was selected as it has highest area under banana cultivation and area under drip method of irrigation. Villages formed the second stage of sampling units, where ten villages were selected randomly. To ascertain the impact of drip technology, "with" and "without" approach was followed. Therefore, 6 drip and 6 non-drip banana growers from each selected villages were selected randomly. Thus, total 120 banana growers comprising of 60 drip and 60 non-drip growers formed an ultimate sample size for the detailed study. The primary data for the study were collected through personal interview method with the help of pre-tested comprehensive interview schedules for the year 2009-10. The major analytical tools employed for the study were tabular analysis with statistical techniques and economic concepts viz.; Cost A, B, C_1, C_2 and production function analysis.

Cost Concepts: The cost concepts used in the tabular analysis are those laid down in the farm management study (kumar *et al.* 2009) and are shown below.

Cost-A: Value of hired human labour + Value of hired and owned bullock labour + Value of tractor charges + Value of plantlet (tissue culture) + Value of manures (owned and purchased) + Value of fertilizers + Value of plant protection chemicals + Irrigation charges + Depreciation + Interest on working capital + Other paid out expenses.

(Cost-A was considered without dividing into Cost- A_1 and Cost- A_2, as there were no tenant farmers in the selected respondents in the present study.)

Cost- B: Cost-A + Imputed rental value of owned land + Imputed interest on owned fixed capital (excluding land)

Cost- C_1: Cost-B + Imputed value of family labour

Cost- C_2: Cost-C_1 + 10 per cent of cost-C_1 as managerial charges

Income Measures: Different income measures (Shah and Zala, 2007) were also used in the analyses which are shown below.

Farm Business Income = Value of gross output – Cost-A

Family Labour Income = Value of gross output – Cost-B Farm Investment Income = Farm Business Income – Imputed Value of Family Labour Net Profit = Value of gross output – Cost-C2

Production Function Model: The Cobb-Douglas type production function (More *et al*. 2006) was used to establish the input-output relation with yield as dependent variable and other inputs as independent variables. The functional relationship is expressed by equation given below.

$$Y = ax_1^{b1} x_2^{b2} x_3^{b3} x_4^{b4} x_5^{b5} x_6^{b6} x_7^{b7} x_8^{b8} e^u$$

Where,

Y = Yield (q),

X_1 = Human labour (man- days),

X_2 = Bullock labour (pair- days),

X_3 = Cost of manures (carts),

X_4 = Cost of plantlet (₹),

X_5 = Cost of fertilizers (₹),

X_6 = Cost of plant protection chemicals (₹),

X_7 = Irrigation charges (₹),

X_8 = Area (ha),

e^u = Error term,

a = Intercept and

$b_1, b_2 \ldots b_8$ = Regression coefficients

Marginal Value Productivity (MVP): Marginal value productivity for the input of Cobb-Douglas production function was derived as under.

$$MVP_i = b_i * Y/Xi$$

Where,

Y = Geometric mean of output Y

X_i = Geometric mean of respective X_i input

b_i = egression coefficient associated the X_i input

Furthermore, the MVP-FC ratio was calculated in order to determine resource use efficiency precisely.

Results and Discussion

Cost of Establishment of Drip System for Banana

The data presented in Table 1 revealed that the total establishment cost on drip irrigation system (DIS) for banana crop was about ₹ 84115/ha. About 64 per cent of the total cost invested was accounted for by the drippers/inline lateral pipes. Out of total cost of investment, 50 per cent amount was given as a subsidy by the Government and remaining 50 per cent incurred by the farmers.

Comparative Economic Analysis of Drip and Non-drip Banana

The average per hectare cost of cultivation of banana was estimated under drip system of irrigation and conventional method of irrigation and the estimates are furnished in Table 2.

Table 1: Per hectare cost of investment on drip irrigation system for banana crop

Particulars	Cost (₹)	Per cent
Main pipe line	6670.08	7.92
Sub main pipe line	4741.98	5.63
Header	5287.34	6.28
Drippers/inline lateral pipes	53536.00	63.64
Filters	6024.93	7.16
Control valves	2675.40	3.18
Flush valve	225.93	0.26
Pressure gauge	273.18	0.32
Start nipple	69.6	0.08
End nipple	63.6	0.07
Joiners	69.6	0.08
Others	4477.59	5.32
Total capital investment	84114.96	100.00

Table 2: Comparative cost of cultivation of banana under drip and conventional (Flood) method of irrigation

Particulars	Drip Farm		Non-drip Farm		Change in drip farms over non drip farms	
	Value (₹)	% to Cost-C_2	Value (₹)	% to Cost-C_2	Amount (₹)	Per cent
Cost-A	113203.88	75.41	115967.80	76.42	-2763.92	-2.38
Cost-B	132042.18	87.97	130742.20	86.16	1299.98	0.99
Cost-C_1	136452.92	90.90	137940.76	90.91	-1487.84	-1.08
Cost-C_2	150098.21	100.00	151734.84	100.00	-1636.63	-1.08

Table 3: Break-up of the total cost of cultivation of banana under drip and conventional (Flood) method of irrigation

Items	Drip farms			Non-drip farms		
	Quantity	Value (₹)	%	Quantity	Value (₹)	%
Hired human labour (man days)	46.28	10758.51	7.16	74.22	13745.88	9.05
Family human labour (man days)	114.35	4410.74	2.93	149.39	7198.56	4.74
Bullock labour(pair days)	5.11	1021.76	0.68	8.54	1784.43	1.17
Tractor charges	-	4096.59	2.72	-	4211.23	2.77
Manures (carts)	-	10672.61	7.11	-	11624.79	7.66
Plantlet (tissue culture)	2966.65	34084.23	22.70	2949.68	34064.67	22.45
Fertilizer (kg) (N+P+K)	-	10570.54	7.04	-	11040.39	7.27
Irrigation	-	8601.33	5.73	-	13423.66	8.84
Plant protection	-	1033.16	0.69	-	1447.30	0.95
Other paid out cost	-	11298.00	7.52	-	11667.53	7.68
Depreciation cost	-	8938.18	5.95	-	529.87	0.34
Interest on working capital	-	12128.96	8.08	-	12425.14	8.18
Rental value of land	-	14324.01	9.54	-	14463.14	9.53
Interest on owned fixed capital	-	4514.29	3.00	-	311.26	0.21
Management cost	-	13645.30	9.09	-	13794.08	9.10
Total	-	150098.21	100.00	-	151734.84	100.00

It could be seen from the table that per hectare total average cost of cultivation (C_2) of banana was slightly less (₹ 1637) in drip farm than that in non-drip farm which used conventional (flood) method of irrigation. So far operating cost (cost-A) is concerned, it was observed that drip banana farmers had to spend less amount (₹ 113203/ha) as compared to non-drip farmers (₹ 115968/ha). On the contrary, it is also notable that Cost-B was more in drip-farm (₹ 132042) than that in non-drip farm (₹ 130742) because interest on owned fixed capital was higher in drip-farm as compared to non-drip farm.

While comparing the break-up of total cost of drip and non-drip banana (Table 3), it was also observed that all the selected farmers used tissue culture (plantlets) for banana cultivation and among the components of the total cost, cost of plantlets occupied highest share in both types of farms i.e. 22.70 per cent (₹ 34084/ha) in drip farm and 22.45 per cent (₹ 34065/ha) in non-drip farm. The second major item of cost in both types of farm was human labour which was required round the year for various operations. It was observed that utilization of human labour was less in drip banana farming (160.63 man-days/ha)

than that in non-drip banana farming (223.61 man-days/ha). This finding is in agreement with the earlier study carried out by Birari and his co-workers (2004). The use of bullock labour was 5.11 and 8.54 pair-day per hectare in drip-farms and non-drip farms, respectively, which indicates there was saving in bullock labour (3.43 pair-day/ha) in drip-farms. The labour requirement was less in drip farms because in addition to saving of labour in irrigation operation, the drip farms also save the labour in ploughing and inter-cultivation as the number of these operations require less since drip method supplies water at the root zone of the crops resulting less weeding problem also.

Thus, reviewing the table overall, it was observed that the cost of important resources viz., human labour, irrigation, manures, bullock labour, fertilizer, plant protection chemicals, and tractor charges was less under drip banana cultivation as compared to the cultivation under conventional method of irrigation. On the contrary to this, it was also observed that depreciation cost and interest on owned fixed capital was higher under drip banana cultivation as compared to non-drip banana cultivation. These findings are in agreement with the earlier result of Narayanamoorthy (2005).

Comparative Returns from Drip and Non-drip Banana

Yield, farm harvest price, value of gross output, overall farm business income, family labour income, farm investment income, net profit and input-output ratios in drip and non drip banana farm are presented in Table 4. The result shows that the average yield per hectare was 701.69 and 616.01 quintal for drip and non-drip banana farm, respectively, which indicate that productivity of banana, was higher (13.94 per cent) under drip irrigation system than that under conventional irrigation system. On an average farm harvest price per quintal received by the drip and non-drip banana growers was ₹ 449.31 and ₹ 421.86, respectively. The drip banana growers received higher price as compared to non-drip banana growers because of high quality of fruits. Thus, as yield and price of banana was higher for drip banana as compared to non-drip banana, the value of gross output was also higher for drip banana (₹ 315283.10/ha) as compared to non-drip banana (₹ 259869.97/ha).

The result also shows that due to the adoption of drip irrigation system, the farm business income, family labour income and farm investment income were increased by ₹ 58177.05, ₹ 54113.15 and ₹ 60964.87, respectively. The net profit per hectare was about ₹ 165185 in drip banana farms whereas; it was about ₹ 108135 in non-drip banana farms. Thus, per hectare net profit was also 52.76 per cent (₹ 57049.76) higher in drip banana as compared to non-drip banana cultivation. Further, reviewing the input-output ratios, it was observed that on the basis of operating cost (Coat-A), the ratio was 2.78 and 2.24 for drip and non-drip banana farms, respectively, whereas over Cost C_2 (total cost), it was 2.10 and 1.71, respectively. It indicates that an investment worth ₹ 1 on all the inputs used in the cultivation of drip and non-drip banana yielded an output worth ₹ 2.10 and ₹ 1.71, respectively.

Table 4: Yield, returns and input-output ratio of banana under drip and conventional (Flood) method of irrigation

Particulars	Category of Farms		Change in drip Farms over Non-drip Farms	
	Drip	Non-drip	Amount	Per cent
Yield (q/ha)	701.69	616.01	85.86	13.94
Harvest price (₹ /q)	449.31	421.86	27.45	6.50
Value of gross output (₹/ha)	315283.10	259869.97	55413.13	21.32
Farm business income (₹/ha)	202079.22	143902.17	58177.05	40.43
family labour income (₹/ha)	183240.92	129127.77	54113.15	41.91
Farm investment income (₹/ha)	197668.48	136703.61	60964.87	44.60
Net profit (₹ /ha)	165184.89	108135.13	57049.76	52.76
Input-output ratio				
Over Cost A	1:2.78	1:2.24	-	-
Over Cost B	1:2.38	1:1.98	-	-
Over Cost C1	1:2.31	1:1.88	-	-
Over Cost C2	1:2.10	1:1.71	-	-

Cost Price Relationship

It is the cost-price relationship that generally decides the economic prosperity and the degree of commercialization on these farms. Given the price, offered by the market mechanism to a unit of output, the farmer's prosperity depends upon his capacity to produce his output at a lesser cost than the market price.

Table 5: Per quintal cost of production and price of drip and non-drip banana

(₹/q)

Different Costs	Category of Farms	
	Drip	Non-drip
Cost-A	161.33	188.25
	(75.42)	(76.42)
Cost-B	188.17	212.24
	(87.97)	(86.16)
Cost-C1	194.46	223.92
	(90.91)	(90.90)
Cost-C2	213.90	246.31
	(100.00)	(100.00)
Average farm harvest price	449.31	421.86
Range of Price	400-525	350-450

Note: Figures within the parentheses indicate percentages to total

The estimated cost of production per quintal of drip and non-drip banana is given in Table 5. The paid-out cost (Cost- A) per quintal for drip and non-drip banana was ₹ 161.33 and Rs 188.25 respectively. The total cost of production (Cost C_2) per quintal of drip banana and non drip banana was ₹ 213.90 and ₹ 246.31, respectively. Thus, it was found that cost of production per quintal of banana was less under drip method of irrigation as compared to that of under conventional method of irrigation. The market price of drip and non- drip banana ranged from ₹ 400 to ₹ 525 and ₹ 350 to ₹ 450 per quintal, respectively. Therefore, it can be concluded that the banana cultivation under drip and non-drip method of irrigation was quit remunerative even if the lowest market price is considered.

Resource use Efficiency

Resource-use efficiency in banana under drip and conventional method of irrigation was separately estimated and the result is presented in Table 6. The value of R^2 (Coefficient of multiple determination) shows that 98.20 per cent and 97.70 per cent of the variation in the yield of non-drip and drip banana, respectively was explained by the equation using explanatory variables (X_1 to X_8). It is inferred that among the explanatory variables of drip banana, cost of banana plantlets (X_4), cost of irrigation (X_7) and area under drip banana (X_8) were positive and significant elasticity at 5 per cent level of significance while for non-drip banana, cost of banana plantlets (X_4) and area under banana (X_8) were positive and highly significant elasticity at 1 per cent level of significance. The sum of regression co-efficient (Σbi's) was 1.072 and 1.109 for non-drip and drip banana, respectively indicating increasing return to scale. Thus, it can be concluded that the drip and non-drip banana cultivators in Anand district of Gujarat are operating in the first zone of production. So, there is some scope to increase the output by optimum use of inputs.

Table 6: Production elasticity of drip and non-drip banana as estimated from Cobb-Douglas production function

Sr. No.	Variables	Production elasticity (bi)	
		Non-drip	Drip
1	X1 = Cost of human labour (₹)	0.114 (0.119)	0.139 (0.092)
2	X2 = Bullock labour charges (₹)	-0.036 (0.100)	0.022 (0.093)
3	X3 = Cost of manures (₹)	0.056 (0.070)	0.105 (0.129)
4	X4 = cost of plantlet (₹)	0.362** (0.122)	0.313* (0.134)
5	X5 = Cost of fertilizer (₹)	-0.013 (0.051)	-0.052 (0.073)
6	X6 = Cost of plant protection chemical (₹)	-0.014 (0.049)	-0.007 (0.007)
7	X7 = Cost of irrigation (₹)	0.075 (0.039)	0.102* (0.050)
8	X8 = Area under crop (ha)	0.528** (0.171)	0.487* (0.200)
9	a = Intercept	1.395	1.598
10	R2 = Co-efficient of multiple determination	0.982	0.977
11	Σbi's = Returns to scale	1.072	1.109
12	N = Number of farms	60	60

Note: Figures within the parentheses indicate standard error of corresponding elasticity.

* Significant at 5% level of significance, ** Significant at 1% level of significance.

Marginal Value Productivity

The marginal value product (MVP) of a particular resource represents the expected addition in gross income caused by an addition of one unit of that resource when other inputs are kept constant. Allocative efficiency (MVP/FC ratio) more than 1 indicates under utilization of particular resource and scope to increase its application till the ratio reaches to one. For examining the resource use efficiency, the marginal value products of those inputs of which regression coefficients were statistically significant, have been worked out in the estimated production function. The data furnished in Table 7 revealed that the MVP/FC ratio for cost of banana plantlets (X_4) and area under crop (X_8) were more than the unity for drip and non-drip banana farms, respectively which indicates the under utilization of these resources. In case of drip banana farms, MVP-factor cost ratio was also more than one (3.62) for irrigation indicates thereby that farmers would gain ₹ 2.62, if they apply an additional unit of irrigation worth ₹ 1. Therefore, it can be concluded that the sample farmers were not using the resources at optimal level. The use of plantlet (X_4), irrigation (X_7) and area (X_8) was less than the required quantum in drip farms indicating these inputs were not optimum in context to other inputs in order to get maximum profit.

Table 7: Marginal value products, factor costs and ratio of marginal value products to factor costs for banana cultivation

Variables	Marginal value product (MVP)		Factor cost	Ratio of MVP to Factor cost	
	Drip	Non drip		Drip	Non drip
X4 = Cost of plantlets (₹)	2.81	2.73	1	2.81	2.73
X7 = Cost of irrigation (₹)	3.62	--	1	3.62	--
X8 = Area under crop (ha)	5.55	4.70	1	5.55	4.70

Conclusions and Policy Implications

The comparative economic study of drip vis-à-vis conventional method of irrigation for banana cultivation indicated that the banana farming under drip irrigation system was found more profitable as compared to conventional method of irrigation in Anand district of Gujarat because the net profit was higher under drip banana cultivation (₹ 165184) as compared to non-drip banana cultivation (₹ 108135). The average yield per hectare was 13.94 per cent higher under drip irrigation system than that under conventional irrigation system. Banana growers also received higher prices for the banana when adopted drip irrigation system as quality was better in drip farms. The input-output ratio over total cost (c_2) was also higher under drip banana cultivation (2.10) as compared to non-drip banana cultivation (1.71) signifying that the investment on drip banana farms was more profitable than that on non-drip banana farms. The analysis of production function indicated that in case of drip banana cultivation, the cost of banana plantlets, cost of irrigation, and area under crop exert significant and positive influence on the gross output whereas for non-drip farm, cost of banana plantlets and area under the crop were found highly significant variables. Furthermore, it was found that the drip and non-drip banana cultivation are operating in 1st zone of production in the study area, indicating there is some scope to increase productivity by optimum use of inputs. As the inputs used under banana cultivation in general and under drip irrigation system in particular were not optimum, further research about quantum and time of application of inputs are necessary for giving proper recommendations to the farmers. Considering findings of the study, the banana growers may be encouraged to adopt the drip irrigation system for banana farming instead of flood irrigation system to get higher income and other benefits. It is also implied that government and extension agency should continue their intensive efforts for promoting drip system of irrigation.

References

Anonymous 2008. District-wise area production and yield of major horticultural crops in Gujarat state, Directorate of Agriculture, Gujarat State, Gandhinagar.

Anonymous 2009. *National Horticulture Database*-2009.

Birari, K.S., Desale, P.G. and Patil, M.R. 2004. An economic evaluation of drip irrigation technique for banana in western Maharashtra, *Agricultural Economics Research Review (Conf.spl.)* **17**: 226.

GoG 2010. Drip irrigation, Agriculture projects & initiatives, Government of Gujarat, Gandhinagar.

INCID 1994. Drip irrigation in India, Indian National Committee on Irrigation and Drainage, Ministry of Water Resources, New Delhi.

Kumar, N.R., pandey, N.K., Rana, R.K. and Pandit, A. 2009. Production and marketing of potato in Bathinda District of Punjab: A comparison of processing and non processing varieties. *Indian Journal of Agricultural Marketing* **23**(1): 43-56.

More, S.S., Shelke, R.D. and Andkalyankar, S. 2006. Labour utilization and input use pattern in banana cultivation. *Agricultural marketing* **48**(1): 21-23.

Narayanamoorthy, A. 2005. Efficiency of irrigation: A case of drip irrigation. *Occasional Paper 45*, Department of Economic Analysis and Research, NABARD.

Shah S.P. and Zala Y. C. (2007) Cost-benefit analysis of ginger cultivation in middle Gujarat, *Artha-Vikas, Journal of Economic development,* **43**(1):19.